Precision Measurement of μ^+ Lifetime

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The goal of the MULAN (**M**uon **L**ifetime **AN**alysis) experiment is a 1 ppm measurement of the positive muon lifetime, τ_{μ^+}. This will result in a 20-fold improvement over previous efforts, an will be reflected in a commensurate increase in the precision of the Fermi constant G_F.

G_F is a fundamental parameter of the Standard Model, since it determines the rate of all electroweak processes. Due to recent theoretical efforts, the dominating uncertainties in G_F are from experiment only. The most direct way to determie G_F is via the lifetime of the muon

$$\frac{1}{\tau_\mu} = \frac{G_F^2 m_\mu^2}{192\pi^3} \times (1 + \Delta q) \qquad (1)$$

with m_μ the muon mass and Δq encapsulating higher order QED and QCD corrections.

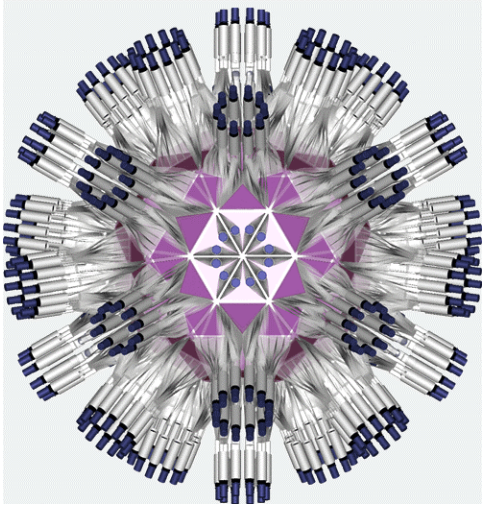

Figure 1: View of the 32-faced, truncated icosahedron structure of the μLan scintillation detector array.

The challenge of this measurement is not only to build a suitable high efficiency detector (Fig.1) which cancels out polarization effects, but also to design a "kicker" muon beamline at PSI (Paul Scherrer Institute) which allows us to maximize the count rate and minimize systematic errors due to pileup effects.

We have studied the residual muon polarization using sulfur and silver targets located inside magnetic fields. The design of the individual detector components is nearly complete.

This year we have also systematically studied the πE3 beamline: We have measured the phase space of the beam with two planar wire chambers, and the absolute muon flux with a small silicon diode detector wich has a depletion thickness matched to separate muons from beam electrons. Fig.2 shows the measured phase space in a) horizontal and b) vertical direction 1 m away from the last quadrupole. We compared our measurements with various beam tune models. The determined beam characteristics are sufficient to allow us to proceed with the kicker design.

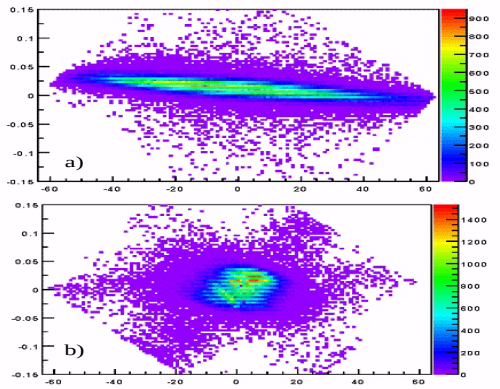

Figure 2: Measured horizontal (a) and vertical (b) phase space of the muon beam.

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